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The Impact of Team-Based Learning on Anxiety Among Graduate Students in a Data Science Master's Program

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Abstract

Objectives: This study aims to explore the impact of Team-Based Learning (TBL) on anxiety levels (AL) among master's students in Data Science, particularly how TBL influences students' anxiety in academic settings and contributes to their engagement, skill development, and learning awareness. *Methods/Analysis:* The study implemented TBL in a Data Science master's course for one semester, employing both qualitative and quantitative methods. Data were collected through surveys and individual interviews, followed by exploratory and statistical analyses conducted in Jupyter Notebook, SPSS Statistics, and Excel. This mixed-methods approach provided comprehensive insights into students' experiences and perceptions regarding TBL and anxiety. *Findings*: The analysis revealed that TBL positively affects students' anxiety levels, contributing to enhanced engagement, individual and group skills, and awareness of the learning process. However, certain TBL elements were found to potentially increase anxiety, suggesting a need for tailored adjustments to the approach. *Novelty/Improvement*: This study underscores TBL's potential to reduce anxiety and foster active learning, emphasizing the importance of student-centered teaching. It highlights specific TBL components that may require modification to minimize negative impacts on student anxiety, offering valuable guidance for educators aiming to create a supportive and effective learning environment.

Keywords:

Team-Based Learning;
Students Anxiety;
Exploratory Analysis;
Generalized Anxiety Disorder.

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1- Introduction

The World Health Organization (WHO) considers mental health an essential component of health [1]. In 2019, around 970 million people worldwide lived with cognitive disorders, with anxiety being the most common, with 31% of the cases [2]. In 2016, around 84 million people in European Union countries had a mental health problem, and anxiety was also the most common mental disorder, with 25 million people affected [3]. Considering these scopes, Generalised Anxiety Disorders (GAD) are a critical issue affecting around 264 million people worldwide, characterised by extreme worry and anxiety toward daily activities [4, 5]. College students are no exception, as they are exposed to numerous problematic situations, such as academic pressure, social challenges, financial stress, and uncertainty about their future careers, all of which can lead to poor academic performance, lack of interest, and difficulties in concentration, ultimately affecting their reasoning and cognitive functioning [6-8]. This scenario was aggravated in January 2020 when WHO declared the COVID-19 pandemic; students reported the highest levels of depression and anxiety compared with other years [9, 10]. The identified causes were disruptions in academic and social panoramas, such as social isolation and lower household incomes and employment [11]. Researchers such as Cooper et al. [7] and England et al. [12] have strengthened active learning approaches focusing on active development and practical knowledge scenarios by agreeing that students should be more involved in their learning progress.

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Active learning (AL) environments, where students engage directly through activities and in-class discussions, have gained significant attention as effective and inclusive teaching strategies, particularly in science education [14]. Research points to a transition from traditional lecture-based models to active learning, as AL has been shown to enhance learning outcomes and reduce failure rates in science courses [15]. This teaching approach has also been recognized for its inclusivity, positively impacting the performance of underrepresented groups, including women, first-generation college students, and students from economically or educationally disadvantaged backgrounds [15, 16].

However, recent discussions have raised concerns about whether active learning is equally supportive of students with mental health conditions [17-19]. Research on anxiety in AL environments has highlighted both benefits and drawbacks. While some active learning practices can reduce anxiety by providing structured feedback and peer support, others—such as high-stakes participation or group activities with unfamiliar peers—can exacerbate anxiety due to the fear of negative evaluation [7, 20]. This fear, characterized by the dread of being judged in social situations, can intensify when students are expected to work with new groups. Conversely, the opportunity to engage collaboratively and receive immediate feedback from peers and instructors has been shown to lessen anxiety, as it clarifies understanding and prepares students for assessments [7, 20, 21]. These findings have led to recommendations for creating inclusive AL environments that accommodate students with anxiety, such as by minimizing high-stakes assessments and providing opportunities for relationship-building within groups [18, 19].

Cooper et al. [7] and England et al. [12] conducted two analyses based on semi-structured interviews and statistical methods where clicker questions, group work, cold/volunteer calls, and group or individual worksheets were implemented. Both analyses provided different perceptions of how the practices can increase or decrease anxiety. Cooper et al. [7] also pointed out that some students considered clicker questions efficient in reducing anxiety, as it helped them to learn science, while England et al. [12] reported that the practice had the lowest anxiety average values compared to the others. The authors from the first paper added that group work could cause fear of negative evaluation; however, the practice was also mentioned as anxiety decreasing because students could discuss and share knowledge with the other members. These perceptions were also explored by Downing et al. [20], who mentioned that although active learning practices have the potential to enhance student performance and decrease anxiety as they provide students with additional access to help from the instructor and other students as well as different approaches to learning, they can also increase anxiety and provoke the fear of negative evaluation linked to social interactions, such as group work or cold calling, as others may perceive that their science knowledge is limited. In addition, Adkins-Jablonsky et al. [21], explored the impact of gamified student response systems on anxiety. They compared it with other active learning practices like clickers, group works, and other everyday classroom activities and discovered that it could cause less anxiety than the majority of those.

Some studies did not focus on anxiety as a primary issue; however, they retrieved some anxiety-related reflections. Al Kawas & Hamdy [22], Rezaee et al. [23] and Feingold et al. [24] discovered that debates among group members could positively impact anxiety and promote an environment that allowed the discussion of the questions while receiving peer support. The first scholars also indicated that TBL could remove pressure from the assessment grades. Additionally, Feingold et al. [24] mentioned that when students work in groups, its influence on their grades can negatively impact anxiety, and Tweddell et al. [25] reported anxiety associated with the practice logistics, fear of the unknown, and fear of not having the necessary skills felt by faculty members.

On the other hand, the studies conducted in this field did not explore differences in how active learning affected students' (AL) [7] or did not include grades in the analysis [12]. Concerning data collection, others relied on only a single time point in the semester [26, 27]. Team-Based Learning (TBL) is a structured form of active learning that emphasises student collaboration and application of knowledge through group work. Developed by Larry Michaelsen in the late 1970s, TBL is designed to transform traditional lectures into a more interactive and student-centred learning experience. While TBL has been shown to improve engagement and understanding, its impact on student anxiety is less clear, with some studies suggesting that the continuous assessment and group dynamics inherent in TBL can either mitigate or exacerbate anxiety depending on the context and individual student characteristics [7, 12].

Some essential elements of TBL distinguish it from other forms of collaborative learning. First, TBL requires students to engage in pre-class preparation and complete assigned readings or materials before class. This preparation ensures students arrive ready to engage in higher-level discussions and collaborative problem-solving during the session [28]. Following this, the TBL process begins with an individual Readiness Assurance Test (iRAT), which assesses students' understanding of the preparatory materials. After the iRAT, students participate in a team-based version of the test (tRAT), where they discuss the same questions as a group and submit a collective response, fostering peer-to-peer learning and discussion [28].

A critical feature of TBL is the application of knowledge through group activities. These activities are designed to challenge students to apply what they have learned to real-world problems or case studies. In addition, peer feedback and continuous assessment are integral to TBL. Frequent team-based quizzes and peer evaluations hold students accountable to their peers and the course content, encouraging sustained engagement throughout the semester [23].

Although TBL shares similarities with other collaborative learning models, such as problem-based learning (PBL) or project-based learning, it stands out due to its structured and formalised nature. In PBL, for instance, students often have more autonomy in selecting and exploring problems, whereas in TBL, instructors present pre-defined problems and guide students through a more controlled process. Moreover, TBL emphasises individual accountability using iRATs and peer evaluations, which ensures that all students contribute equally to their team's success [28].

Team-Based Learning offers several advantages that make it a valuable addition to curricula across various fields. Not only does TBL foster essential team-building skills, but it also serves as an effective teaching method to enhance student learning outcomes [29]. One notable benefit of TBL is its ability to foster a greater sense of connectedness among students and between students and instructors, whether in face-to-face or online courses. This sense of community and support is often stronger in TBL environments than in traditional, non-TBL courses, contributing positively to student engagement and motivation [30]. Additionally, TBL is increasingly recognized as a learner-centered approach that promotes active engagement, making it particularly well-suited to developing critical thinking and problem-solving skills. In fields such as nursing education, where practical decision-making and collaboration are crucial, TBL has proven especially beneficial in helping students apply theoretical knowledge to real-world scenarios, enhancing both their academic performance and professional preparedness [31].

TBL's structured approach can have varying effects on student anxiety. On the one hand, TBL can mitigate anxiety by providing students with a collaborative environment where they can rely on their peers for support. Regular feedback from peers and instructors helps reduce the stress associated with high-stakes assessments by offering ongoing opportunities for improvement throughout the course [7]. This continuous feedback loop can help alleviate the pressure of individual performance and improve students' confidence in their learning progress [24]. On the other hand, TBL's frequent assessments, such as iRATs and tRATs, as well as the inclusion of peer evaluations, can sometimes exacerbate anxiety. Students uncomfortable with public accountability or group dynamics may feel increased stress in these situations [25]. The requirement to demonstrate preparedness in front of their peers can lead to heightened performance pressure, and the fear of being judged by their team members may further contribute to anxiety [7]. The balance between mitigating and exacerbating anxiety largely depends on individual student characteristics and how well they adapt to TBL's collaborative structure.

Table 1 presents the research that provides some relation between active learning and anxiety, even if identifying that relation was not the central scope. Most studies performed individual interviews or statistical analyses by combining different students' characteristics and anxiety scales. We adapted some instruments and methodologies from those sources to this stream of research. As in the Cooper et al. [7] study, we implemented the GAD-7 scale developed by Spitzer et al. [32], as well as the semi-structured interviews from England et al. [12] the mixed-methods implementation, and from Rezaee et al. [23] the statistical approach to compare two different points in time or groups. The studies in which the main scope was the relation between anxiety (identified with an asterisk) did not apply TBL and gathered the student's characteristics such as age or sex, and in the academic field, their course, prior experience with the practice or skills obtained rather than the grades obtained in each activity.

This study used a quantitative approach to measure students' anxiety levels (AL) in a Data Science master's course where a team-based learning (TBL) pedagogical approach was implemented. Subsequently, we conducted semi-structured interviews with students to explore the possible impact of TBL implementation on the measured anxiety levels. We employed a mixed-method approach to provide a comprehensive understanding of how TBL affects student anxiety. The complexity of anxiety as an emotional response, combined with the structured pedagogical framework of TBL, necessitates both quantitative and qualitative insights. The quantitative approach allows for the measurement of anxiety levels across a large sample using psychometrically validated tools, providing statistical evidence of changes in anxiety levels before and after TBL. Meanwhile, the qualitative component delves into students' experiences and perceptions of TBL, offering rich contextual data that explains the patterns observed in the quantitative analysis.

We addressed the research question: "What is the impact of TBL on students' anxiety levels in a Higher Education Institution?"

The following research objectives are defined:

- Quantitatively measure students' anxiety levels (AL) in a Data Science master's course implementing a team-based learning (TBL) approach.
- Explore qualitatively the relationship between the measured anxiety levels and the impact of implementing TBL through semi-structured interviews with students.

Table 1. Active Learning and Anxiety Studies

Ref.	Pedagogical Approaches	Instruments	Methods	Data	Relevant variables
Li et al. (2024) [33]	Clicker Questions, Group Work, Cold Calling	Online Survey, Anxiety Scale	Quantitative (Structural Equation Modeling)	186 University Students	Anxiety Levels, Student Performance, Instructional Design
Ifenthaler et al. (2023) [34]	Digital Learning Environments	Social Anxiety Scale	Quantitative (Survey Analysis)	666 University Students	Social Anxiety, Digital Learning Contexts, Cultural Differences
Cooper et al. (2023) [35]	Active Learning in Science Courses	Semi-Structured Interviews	Qualitative	29 Undergraduate Students with Depression	Depression Symptoms, Active Learning Experiences
Brigati et al. (2020) [26]	Clicker Questions, Group Works, Cold/Random Calls	Online Survey, Own Anxiety Scale	Quantitative (Frequencies, Means, Cohen's Kappa, Bar charts)	880 Biology College Students	Year in School, Gender, Ethnicity, Anxiety Distribution, Coping Categories
Downing et al. (2018) [7]	Clicker Questions, Group Works, Cold/Random Calls	GAD-7 Scale, Interviews	Qualitative	52 Biology Students	GAD-7 Score, Gender, Ethnicity, College Generation
Cooper et al. (2018) [7]*	Clicker Questions, Group Works, Cold/Random Calls	GAD-7 Scale, Semi-structured Interviews	Qualitative	52 Biology College Students	GAD-7 Score, Class, Gender, Ethnicity, First-Generation College Going, Anxiety Effect
England et al. (2017) [12]*	Clicker Questions, Worksheets, Volunteering Answers, Cold Calls, Group Works	Online Survey (Adapted Research Anxiety Scale), Individual Interviews	Mixed methods (Interviews, one-way ANOVA, Tukey's posthoc analysis, two-tailed T-tests, Cohen's F)	327 Biology College Students	Course, Year, Gender, Race, AL
Kawas et al. (2017) [22]	Peer-Assisted Learning/TBL	Questionnaire/Focus Group Interviews	Quantitative (Frequencies)	38 Dental Students (Questionnaire), 16 Dental Students (Focus Group)	The effect of PAL/TBL on learning, teaching, communication & social skills
Rezaee et al. (2016) [23]	TBL	Questionnaire	Quasi-experimental (Paired T-tests)	25 Management Students	Pre and post-test knowledge Retention, Final Exam, TBL & Lecture Satisfaction
Tweddell et al. (2016) [25]	TBL	Semi-Structured Interviews	Qualitative	19 Pharmacy Faculty Members	Discipline, Number of Years Teaching, Experience using other methods before TBL, Number of Years Using TBL, TBL perceptions
Deardorff et al. (2014) [36]	TBL	Survey	Quantitative (Chi-square tests)	175 Medical Students	TBL Survey Domains (General, Participation & Communication, Intra-Team Discussion, Perceived Effort, Teamwork Skills
Ofstad & Brunner (2013) [37]	TBL	Literature	Qualitative	Nursing. Medical, Pharmacy Literature	-
Chen et al. (2008) [38]*	PBL	Liebowitz Social Anxiety Scale (LSAS) modified to fit PBL	Quantitative (Frequencies, Means, Standard-Deviations)	23 Medical Students (Taiwanese, American, Asian)	Age, Gender, Prior Experience of PBL, 8-item LSAS
Feingold et al. (2008) [24]	TBL	Observation During Classes, Interviews	Qualitative	48 Nursing Students	Age, Gender, Academic Characteristics

2- Material and Methods

This study used positivist developmental mixed-methods research. In a positivist developmental mixed-methods study, the researcher would take a scientific approach to studying development over time, using quantitative data (such as test scores) and qualitative data (such as interview transcripts) to understand the research question from different angles. There are four main mixed methods designs: convergent parallel design, where quantitative and qualitative data are collected and analysed separately, and then the results are merged to confirm or contradict each other; embedded design, where one type of study (quantitative or qualitative) provides a secondary role within a design framed by the different type; explanatory sequential design where qualitative data helps explain quantitative results obtained earlier in the study and exploratory sequential design where quantitative data builds on the initial qualitative results [39].

Our proposal uses test score data from GAD-7 to assess anxiety and then combines that analysis with the assessment scores obtained from the students during the semester. Since many factors besides TBL could affect anxiety during the semester, we interviewed a group of students to understand the impact that TBL had on their anxiety.

2-1- Course Design

Team-based learning (TBL) is an active learning pedagogy developed for in-class sessions and based on the collaborative work of small groups of students. One of the benefits of TBL is the promotion of highly in-demand skills development, such as personal relationships, group learning, and critical thinking skills. The course consists of 14 weeks of classes, corresponding to 7.5 ECTS. Seven classes are theoretical, and the remaining seven are practical. Each class has a two-hour duration. Table 2 presents the sequence and topics covered, where it is possible to see that we implemented 6 TBL classes followed by practical classes where an application exercise was proposed.

Table 2. Course Topics by Class and Pedagogical Approaches

Week	Topic	Pedagogical Approach
1	Presentation of the Course; Introduction to Data Mining.	Traditional Class
2	Data Visualisation; Data Understanding	TBL Class
3	Python Basics – Review	Practical Class
4	Data Pre-Processing	TBL Class
5	Data Pre-Processing Activity	Practical Class
6	Association Rules and the Apriori Algorithm	TBL Class
7	Association Rules Activity	Practical Class
8	RFM Model; Introduction to Clustering: K-Means	TBL Class
9	K-Means Activity	Practical Class
10	Cluster Analysis: Soms	TBL Class
11	SOM Activity	Practical Class
12	Cluster Analysis: Birch and DBSCAN	TBL Class
13	Birch and DBSCAN.	Practical Class
14	Group Project	Practical Class

Professors created teams at the beginning of the semester that were immutable for the whole semester. Each team was comprised of six students and was made from a short survey of students identifying their background and experience in the topics covered. Teams were formed as heterogenous groups, including students from different backgrounds and experiences.

The TBL was conducted with the help of LAMS [40], an online TBL platform, in a higher education institution in the 2021/2022 fall semester in a Data Mining course. The course included first-year students from different masters. The TBL approach in this course was structured to maximize student engagement and understanding through a sequence of preparation, assessment, and application phases. The process began with Pre-Class Preparation, where students were given access to essential readings, presentations, and instructional videos one week before each session. This preparatory material ensured that students arrived at class with a foundational understanding of the topic.

Each class session commenced with an Individual Readiness Assurance Test (iRAT), consisting of multiple-choice questions designed to assess individual comprehension of the preparatory material. Following the iRAT, students took a Team Readiness Assurance Test (tRAT), where they answered the same questions as a team, promoting peer discussion and reinforcing learning through collaboration. Immediate feedback was provided during the tRAT, allowing teams to clarify misunderstandings in real-time. After the readiness assessments, teams engaged in Application Exercises. These exercises included complex, real-world problems or case studies related to data science, requiring students to apply course concepts in a practical context. The application phase encouraged critical thinking and problem-solving, as teams worked together to devise solutions and justify their approaches. At the semester's start, teams were intentionally composed to balance skill levels and backgrounds, ensuring diversity in each group. Criteria for team formation included academic background, experience in data science, and complementary skills (e.g., programming, statistical analysis). Teams remained consistent throughout the course to strengthen group cohesion.

The effectiveness of each team was assessed through performance metrics (average scores on tRATs and application exercises), peer evaluations (where students rated each other’s contributions and collaboration), and self-reflections. These assessments provided insights into team dynamics, enabling instructors to monitor team performance and address any issues promptly. To build the questions for the iRAT and tRAT, we used the 4S framework [28]. This schema means using significant problems, having all students work on the same problem, requiring them to make a specific choice, and enabling simultaneous reporting.

During the tests, professors receive feedback from students through students' performance in answering the RAT questions and from the burning questions. Burning questions are comments and questions that students can write during the tRAT assessment. Students can record any comments, disagreements or clarifications that will be analysed and discussed within the class later. Both allowed the teachers to explain or clarify misunderstood concepts. Finally, an application exercise covering the topics learned during the class was proposed to students, who were meant to solve it with their teams. Some of those exercises were evaluated and called handouts. Table 3 presents several evaluation elements that contributed to the final grade, including TBL, in bold, and non-TBL items.

Table 3. Evaluation Elements

Evaluation	Quantity	Contribution to the Final Grade (%)
Quiz Python	1	5
Individual Readiness Assurance Test (iRAT)	6	2.5
Team Readiness Assurance Test (tRAT)	6	2.5
Handout 1	1	5
Handout 2	1	5
Final Project	1	35
Exam a	1	20
Quiz Python	1	5

2-2- Data Collection

The Research Ethics Committee from the institution approved this research (STAT2022-11-37997), and we obtained informed consent from all the participants.

It comprised two surveys and several semi-structured individual interviews during one semester (Figure 1). After collecting all the information, the interviews were coded to move from the raw data to the findings using structural coding, aiming to characterise a segment of data retrieved from the semi-structured interviews based on its content. All the students enrolled in the TBL data mining course were approached to participate in this study, as it was not considered an exclusion or inclusion criteria, and it was the only course applying this active learning practice. Despite that, only some agreed to answer the surveys, having the final sample of those students.

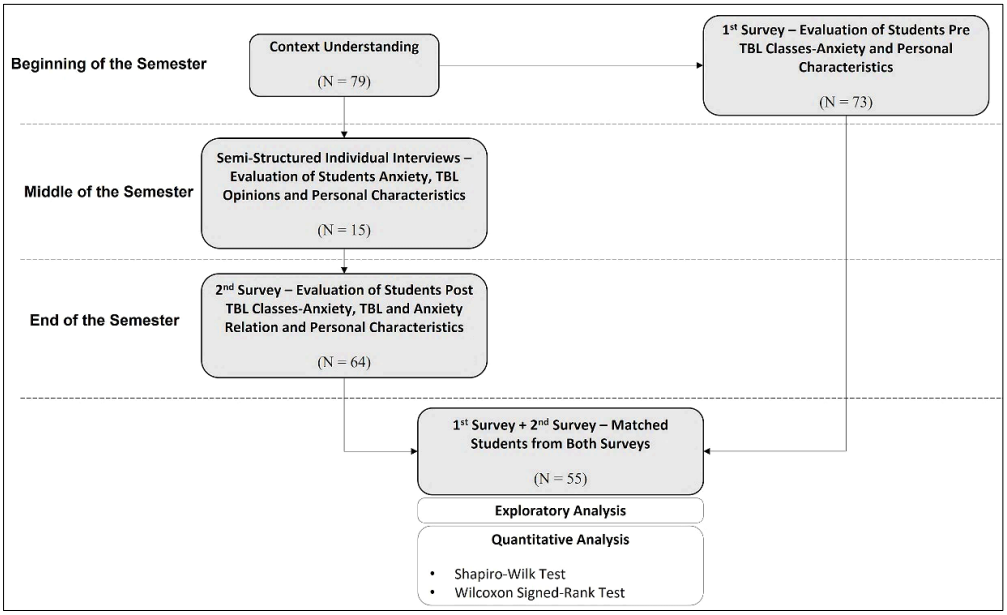

Figure 1. Overview of the Research Methodology for Evaluating Anxiety in Team-Based Learning Context

During the first class, 73 of the 79 students agreed to answer a first survey to perceive their AL at the beginning of the semester and get to know their personal and academic characteristics. This survey combined a 7-item Generalised Anxiety Disorder scale (GAD-7) (Appendix A) [32] and questions such as age, sex, master's program, course format, and student number. The GAD-7 is a self-reported instrument that uses a four-point Likert scale ranging from “Not at all” to “Nearly every day” answer choices. This instrument measures anxiety on a continuum by assigning a score between 0 and 21 according to the respondent's answer [7, 32]. The Generalized Anxiety Disorder-7 (GAD-7) survey was chosen for this study due to its proven reliability, validity, and suitability for measuring anxiety in academic settings. The GAD-7 is a brief, accessible tool with strong psychometric properties, making it effective for capturing anxiety levels without overwhelming participants. Its use is well-established in educational research, where it allows for consistent, comparable measures of anxiety across studies. Given the pressures faced by graduate students in a rigorous data science program, the GAD-7 provided an efficient and appropriate method for assessing anxiety within this specific population.

Scores between 0 and 4 correspond to minimal anxiety, 5 and 9 to mild anxiety, 10 and 14 to moderate anxiety, and 15 and 21 to severe anxiety. After the first survey, we conducted semi-structured interviews study (Appendix B) in the middle of the semester, as the students had already participated in at least one TBL class. This study aimed to collect their opinions about TBL and its impact on their anxiety.

The questions were formulated based on similar qualitative studies. They were divided into different parts, which comprised general questions about the TBL practice, participants' experience in online TBL classes, if applicable, the pre-class preparation phase, class phase (iRAT, tRAT, application exercise, and handouts), teachers influence on the classes and personal questions about the participant.

Students were invited to participate in a semi-structured individual interview, including inquiries about the TBL class phases, teachers, and personal questions. Fifteen interviews were obtained, lasting between 30 minutes and 1 hour, allowing the confirmation or denial of the information gathered from the literature and the development of the second quantitative analysis. Like Olubiyi et al. [41], the interview responses collected the most common terms, related words and phrases to describe concerns about TBL and anxiety. We employed structural coding, a question-based code that relates a research question that framed the interviews with their content, so each topic is associated with a question [42]. In this case, the research objective was explored, and the embedded research question was "What are the situations/activities in the TBL class that impact students' AL?". After that, the number of participants who mentioned that particular theme was determined to identify which themes, ideas, or domains were more common and which could increase or decrease anxiety [43, 44]. Table 4 presents the formed categories, the students' statements, and their impact on the AL.

Table 4. Interview Categories and Students' Opinions

Category	IsA*	Students' statements
Class Preparation	↑	"As I am working, having a fixed period to study becomes hard to conciliate."
		"The amount of time is short, especially when the teachers only provide the materials during the weekend."
Contents	↑	"We get apprehensive with papers provided, regarding their size. (…) it makes us think that it will be difficult to read."
		"(…) I become anxious to see if what you learned is well consolidated."
		"In the beginning, I was anxious (…) I did not know what to expect from the quizzes."
		"Before the iRAT I am anxious (…) I do not know what to expect."
		"I become anxious, and I wonder if what I searched on the internet is equivalent to all those pages of the documents."
	↓	"Gives me confidence knowing that the materials are available at any time."
		"Less anxious, as I am already prepared before the class."
		"It reduces my anxiety, and I am more prepared as I study over time. (…) for the projects & exam, we are much more aware of the contents."
		"I am more attentive to the classes and know what we are talking about."
		"I am less anxious for the tRAT and know that all the team members know the contents."
Autonomous Learning	↑	"As we prepare the contents alone, I feel more anxious (…) we create our ideas, and sometimes those ideas are wrong."
		"More anxious, I am being evaluated on a thing that nobody taught me as I read the materials alone."
Other Modules	↑	"The class took place on the same day as two other evaluations in other modules, and I felt anxious."
		"In other modules, teachers are using PBL. It is hard, especially when both have many contents to study or evaluations."
Team Grades Influence	↑	"I feel more anxious in the group activities as they do not depend only on me."
		"I feel a bit upset that the group got it wrong, especially when I say that the answer should be another."
		"When we have to do the tests, there is an additional responsibility, it is a part of the grade, and we want to have good grades, especially in the group activities. We are with others and do not want to influence them to choose a wrong answer and lose points, so we feel more anxious."
		"The teams can influence the individuals' grades (…) we are condemned to a choice that is not ours. Colleagues were anxious regarding the people that could be on their team."
		"I feel more anxious in the individual test, and I know that my test will influence the team's answers."
		"The iRAT is when I feel more anxious, it only depends on me, and it is the first time I see the questions."
	↓	"I feel more relaxed before the tRAT; it is the second time that I see the questions. I feel more comfortable in the group and have better grades."
Comparison between students' Knowledge	↑	"I feel the pressure; I do not want to fall behind my colleagues in the exercises (...); I feel anxious due to that comparison."
		"(…) if I do not have the same answers as my colleagues, I feel more anxious; I think I have done something wrong."
Team Dynamics	↑	"As we have evaluations, we feel much more anxiety (...) we have to create a dynamic with people we do not know."
		"You are not completely at peace (…) some people could be incompatible, (…) reaching consensus with people we do not know, if they want the same as us academically."
		"In the TBL, I feel more anxious; we have evaluations and need to debate the answers, which could create conflict."
		"The teams can influence the grades of one person."
		"I am the leader (...) I feel that I work more."
		"We have an additional responsibility as leaders (…) I feel a bit anxious when we do not have 100% confidence in the answer."
		"We do not have the time to finish the application exercise (…) we needed to do it at lunchtime, and some of the people did not stay, which made us feel a little bit anxious; we needed to finish it faster."

* IsA stands for impact on students' anxiety

Category	IsA*	Students' statements
Teams Members	↓	"I did not know anyone, so I was worried." "It makes sense since we cannot choose the people we work with in the future in a professional context."
Team Support	↓	"The anxiety decreases in group activities, (…) there are more people thinking & colleagues very confident in their answers." "(…) we see different perspectives and ideas from people with different backgrounds, the decision is easier."
TBL Practice Novelty	↑	"For at least 15 years, we are used to having a book and studying for tests. Changing this method is a big difference. For me, it is not very clear. I need to prepare for the class with many PDFs to study, and I feel I do not learn that much." "Teachers should not trust our self-taught capabilities that much. They could make the slides available as in the previous years." "We spend much more time in this module than in others." "We only feel more anxious about the traditional methodology's final exam. I feel more anxious in the TBL because I only read the materials once or twice, and I have a quiz that affects my grade."
Evaluations Frequency	↑	"Constant evaluations cause me anxiety."
Content Uncertainty	↑	"The tests have just a few questions; if we have one wrong, the demeritis a lot." "I feel anxious, worried & frustrated. I lost an entire day preparing & for the test, and I do not know the answer."
Practical Exercises Difficulty & Duration	↑	"In the handout, I feel more anxious; it is complicated." "In the Python part, we do not have much time to study. (…) I feel anxious when I do not have the same answers as my colleagues." "We do not have time to finish the application exercise during the class. We all have different schedules, so, it is hard to conciliate them to deliver on the same day. (...) Some of my group members feel anxious & afraid of having answered wrongly." "On the first handout, the class time was not enough." "I feel anxious, and I already know I will not have enough time to do it all and must do it at home."
Skills gained	↓	"The fact that we had practical exercises very similar to what we need to deliver in the project reduces the anxiety associated with it."
Future Evaluations	↓	"(…) the grade is not only built by a unique evaluation moment if we perform badly in that evaluation the grade is not damaged & I feel more relaxed." "As I have the information available to read, I already saw the contents more than once; it will be easier to study in the future & will reduce anxiety." "Studying during the semester makes me more relaxed for future evaluations; I will not have to study all the contents quickly." "Having the contents up to date (…) we do not reach the practical classes without knowing how to apply the concepts. The anxiety decreases as the exam does not significantly impact the grade."
Doubts Clarification	↑	"Being evaluated & not having the opportunity to clarify doubts."
	↓	"Clarifying doubts in a faster way with the group helps me. Having the teacher and the burning questions help to clarify the doubts faster." "As I am a bit shy, I feel more comfortable exposing my doubts through the group burning questions."
Teachers Interactions	↓	"(…) more anxiety for the exam, I do not know which is more important to the teacher." "The teachers could give feedback at the beginning of the class or explain the contents at the end."
Teachers Performance	↓	"During the practical classes, the teachers go to the groups & try to help & that reduces my anxiety; I feel more supported." "Teachers ask for feedback about the classes and how they can improve. I think they attenuate a lot the anxiety; we trust them." "I think they try to reduce the AL; they do not put pressure on us with the time of the activities & they also check who did not deliver yet & understand why."

The second survey (Appendix C) was disseminated online at the semester's end. It aimed to deepen the opinion on the issues defined and the impact of TBL on anxiety and collect the students' AL at the end of the semester. It incorporated the views of 64 students and was divided into three main categories: the GAD-7 scale, the personal information questions (age, sex, nationality, home city, working or not, master specialisation, online or presential class attendance, student number), and TBL class questions. The latter was divided into five sub-categories containing the TBL classes' general questions, pre-class preparation, iRAT, tRAT, and Application Exercise/Handout. Those results were then combined with the student's intermediate and final grades.

The mixed-methods approach employed in this study helped understand students' anxiety levels in several ways. First, the study benefited from data triangulation by combining quantitative and qualitative data. While the quantitative component provided objective, numerical measurements of anxiety levels, the qualitative component offered more profound insights into the students' experiences and perceptions related to anxiety. Also, the quantitative and qualitative methods complemented each other, allowing for a more holistic understanding of the phenomenon. While the psychometric scales provided a snapshot of anxiety levels at different time points, the semi-structured interviews enabled the exploration of the underlying reasons, contexts, and nuances associated with changes in anxiety levels. Finally, the qualitative component allowed students to share their experiences, perspectives, and contextual factors related to anxiety levels, which added richness to understanding the anxiety levels beyond the quantitative measurements alone.

2-3- Data Analysis

We combined the two survey answers and considered only the students who had answered both. We obtained answers from 55 students. Afterwards, EDA and statistical analyses were performed. We cleaned the dataset, identified anomalies [45] and outliers, and checked through box plots and z-scores [46]. After the data modifications, we performed the statistical tests using SPSS Statistics and Jupyter Notebook [12, 23, 47]. The GAD-7 anxiety scores we obtained at the beginning and end of the classes were compared with the grades and other variables in Excel.

The Shapiro-Wilk test was carried out to identify the pre-class (PRCA) and post-class anxiety (PCA) scores sample distribution normality [48] along with Q-Q Plots. Consequently, we run a Wilcoxon Signed-Rank Test. This test relies on two hypotheses: the null hypothesis, which assumes that "the median of the anxiety differences between the pre and post-TBL classes is zero 0", and the alternative hypothesis, which assumes that "the median of the anxiety differences between the pre and post-TBL classes is different from 0" [49]. We believe the first survey provided the students' anxiety before TBL, and the second survey provided the students' anxiety after TBL. Then, the positive, negative, and tied ranks were explored in the Wilcoxon Signed-Rank test.

3- Results

Combining both surveys allowed us to retrieve 55 student results, where 45.45% identified themselves as female and 54.54% as male, aged between 21 and 35. In most cases, the student's nationality is Portuguese. When examining the master's program specialisations, 87.27% of the students were enrolled in Knowledge Management and Business Intelligence and 12.73% in other Data Science specialisations, with the majority attending the classes in person. It was also possible to verify that 74.54% were not working and only 25.45% were working.

At the beginning of the semester, students with minimal anxiety reported an average of 2 points, while at the final of the semester, it increased to 2.73 (Table 5). Regarding mild anxiety, 6.59 points were reported at the beginning and 6.22 at the end. For moderate anxiety, the average was 11.38 in the first survey and 12.09 points in the second and for severe anxiety, the scores were 18 points at the beginning of the semester and 18.55 at the final, respectively.

Table 5. Anxiety Type Statistics

Anxiety Type	1st Survey			2nd Survey		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation
Minimal (0-4 points)	26	2.00	1.36	25	2.73	1.44
Mild (5-9 points)	17	6.59	1.50	28	6.22	0.94
Moderate (10-14 points)	8	11.38	1.06	11	12.09	1.64
Severe (15-21 points)	4	18.00	2.16	11	18.55	2.07

Table 6 shows that students with the highest anxiety scores presented the highest average grades. In the first survey, the highest average grades were mainly associated with moderate and severe anxiety levels for all the TBL elements. In contrast, in the second survey, the highest grade values were related to severe anxiety levels. Considering the Final Grade, the students with severe anxiety levels achieved the highest values, 16 points. The individual tests (iRAT) presented lower grades than group tests, with average grades around 13 and 14 points, while the values were consistently higher than 17.5 points in the second. Regarding handouts, the highest grades were verified in the moderate and severe students, with average values of 18.03 points and 17.79 points, respectively.

Table 6. TBL Evaluation Elements Average Grades per Anxiety Type

	1st Survey				2nd Survey			
	Minimal	Mild	Moderate	Severe	Minimal	Mild	Moderate	Severe
Final Grade Average	15.07	15	15.50	16	14.80	15.22	14.82	16
iRAT Average	13.36	13	14.33	13.91	13.35	13.22	13.09	14.27
tRAT Average	17.83	18	18.78	19.075	18.32	17.53	17.96	19.04
Handouts Average	17.47	18	18.03	17.31	17.48	17.52	17.54	17.79

3-1- Differences between Pre and Post Class-Anxiety Scores

In the Shapiro-Wilk test, a p-value below 0.001 was obtained under the 0.05 significance limit, allowing the confirmation that the data does not follow a normal distribution (Table 7), so a nonparametric Wilcoxon Signed-Rank test was performed. In this test, we rejected the null hypothesis as the p-value was under the 0.05 significance level limit, revealing the differences between the AL medians before and after implementing the TBL classes (Table 7). After

performing the test, we verified that the number of positive ranks was higher, which indicates that most students presented higher anxiety levels in the second survey (Table 8). In addition, in Table 9, we identified that of the twenty-six students with minimal anxiety in the first survey, most evolved to mild anxiety; of the seventeen who presented mild anxiety in the first survey, they got moderate anxiety levels in the second survey. Of the students with moderate anxiety, five evolved to severe anxiety. Of those four students with severe anxiety in the first survey, 3 maintained the level of anxiety, and one decreased it to minimal in the second survey.

Table 7. Shapiro-Wilk and Wilcoxon Signed-Rank Tests Results.

	1st Survey					2nd Survey	
	N	Statistic	Degrees of Freedom	Mean (Standard Deviation)	Significance	Z	Asymptotic Significance (2-sided test)*
PRCA (1st Survey)	55	0.902	55	5.95 (4.968)	<0.001	-3.996	<0.001
PCA (2nd survey)	55	0.916	55	8.91 (6.007)	<0.001		

Table 8. Wilcoxon Signed-Rank Test Ranks.

	Ranks		
	N	Mean Rank	Sum of Ranks
Negative Ranks	9 [a]	20.78	187
Positive Ranks	38 [b]	24.76	941
Ties	8 [c]		
Total	55		

[a.] PCA (2nd Survey) < PRCA (1st Survey)

[b.] PCA (2nd Survey) > PRCA (1st Survey)

[c.] PCA (2nd Survey) = PRCA (1st Survey)

Table 9. Active Learning and Anxiety Studies.

PRCA	PCA	Number of Students	PRCA Mean Score (1st Survey)	PCA Mean Score (2nd Survey)
Minimal (26)	Minimal	10	1.4	2.7
	Mild	11	2.72	6.27
	Moderate	4	1.5	12.25
	Severe	1	2	15
Mild (17)	Mild	5	6.4	6.2
	Minimal	4	6	2.5
	Moderate	6	6.3	12.17
	Severe	2	9	17
Moderate (8)	Moderate	1	11	11
	Mild	2	11	6
	Minimal	0	0	0
	Severe	5	11.6	19.4
Severe (4)	Severe	3	18	19.33
	Minimal	1	18	4
	Mild	0	0	0
	Moderate	0	0	0

3-2- Differences between Pre and Post Class-Anxiety Scores by factors

Figure 2 presents the analysis of Anxiety level differences between Survey 1 and Survey 2 across factors such as students' nationality (Foreign vs. National), students' age groups (<=21, 22–24, >=25) , professional status (Working vs. Not Working) and type of classes attended (Online vs. Presential).

For each factor we present a graph with the number of students per anxiety level difference (e.g. -1 means the student evolve from a more severe anxiety type to a one level less one, and +2 means the student increased two levels on the anxiety type. Also for each factor we present the average of the anxiety level type (1-Minimal, 2-Mild, 3-Moderate and 4-Severe).

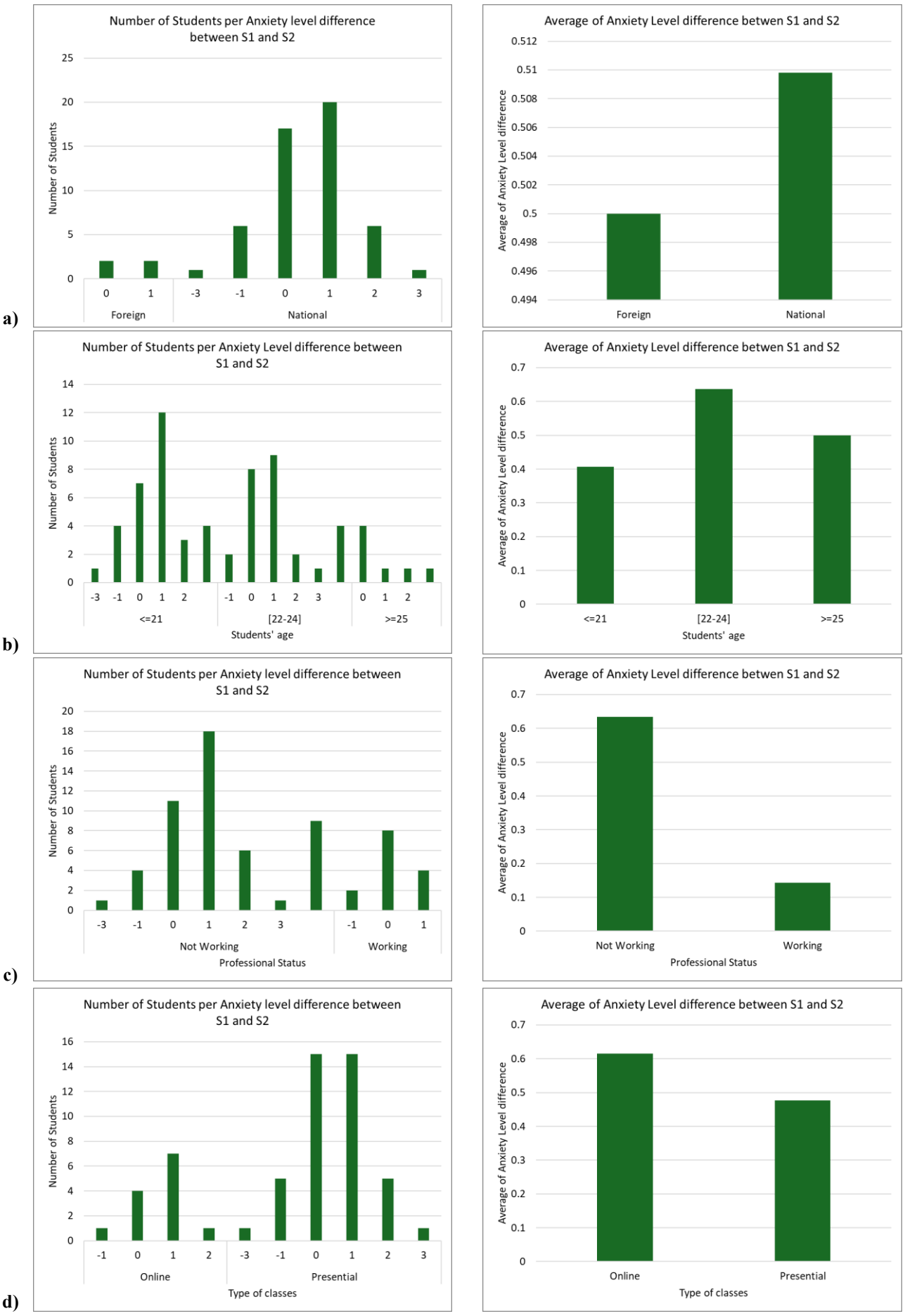

Figure 2. Analysis of Anxiety level differences between Survey 1 and Survey 2 across several factors (a- students' nationality; b- students' age; c-professional status and d-type of classes.

From Figure 2, each factor reveals patterns that help us understand the students' anxiety differences. For nationality, national students displayed a higher tendency to experience slight positive differences in anxiety levels (between 0 and +1), whereas foreign students exhibited a more balanced distribution of changes. This suggests that foreign students might have a more stable experience in terms of anxiety changes. The average anxiety level difference further supports this observation, as national students showed a slightly higher average increase in anxiety compared to foreign students, whose average remained closer to neutral.

Regarding age groups, students aged between 22 and 24 constituted the largest group and showed the highest average increase in anxiety levels, followed closely by students aged >=25. These students also tended to experience slight positive differences in anxiety levels more frequently. Students aged <=21 had the lowest average anxiety difference and a larger proportion of neutral or slightly negative changes, suggesting that this younger group might exhibit greater resilience or encounter fewer anxiety-inducing challenges.

For professional status, students who were not working exhibited a significant number of slight positive anxiety differences (+1), while working students showed a more evenly distributed range of changes, with many remaining neutral. The average anxiety level difference highlighted this disparity, as non-working students had a much higher average increase in anxiety levels compared to working students. This could be due to working students having developed better coping mechanisms, time management skills, or maturity from balancing their studies and jobs.

The type of classes also played a role in anxiety level differences. Students attending presential classes were more likely to experience slight positive differences in anxiety levels (0 to +1), while online students had a more dispersed distribution, including neutral and slightly negative differences. In terms of average anxiety levels, students in presential classes experienced higher average increases in anxiety compared to those in online classes, indicating that virtual learning environments might provide a more relaxed setting for some students.

Overall, this analysis reveals that nationality and professional status are significant differentiators in anxiety changes, with national and non-working students experiencing the highest anxiety increases. Age group differences show that older students tend to face more anxiety level increases, likely due to greater academic or professional pressures. Finally, the type of classes indicates that presential learning environments might contribute more to increased anxiety compared to online settings.

4- Discussion

4-1- Team-Based Learning Impact on Student's Anxiety

Similarly to other authors, in this study, we employed a mixed-methods approach to have a comprehensive understanding of the impact that TBL can have on the anxiety levels of students. We collected quantitative data on students' anxiety levels (AL) through psychometric scales administered at the beginning and end of a Data Science master's course incorporating TBL. The statistical analysis suggests that there was an overall increase in anxiety levels among students. This change was particularly evident in the transition of students from lower anxiety levels (minimal and mild) to higher levels (moderate and severe). Since factors other than the TBL approach can cause this increase, we analysed student interviews. Table 4 presents the opinions of the students collected from the interviews on 18 main topics that affected students' anxiety.

Through the analyses, it was also possible to verify that the student majority considered that the general TBL practice was not a cause of anxiety and did not cause more anxiety than a traditional class (Figure 3), similar to what Lin [50] discovered. We also found that the constant low-weighted evaluations that promoted them to study during the semester, the content, and the learning process awareness decreased anxiety in the final assessment. In addition, forty-two percent of the students agreed that they felt less anxious about the exams and handouts (graded exercises) due to the opportunity TBL provides to practice more. These perspectives are in line with Cooper et al. [7], in which students felt that the tests allowed them to identify which contents they did not understand, while in a traditional class, the material was just presented, and only at final exams did they got the chance to assess whether contents were fully understood or not. Furthermore, when asked if anxiety could be related to conciliating TBL with the other classes, 25 students disagreed or strongly disagreed.

Despite the previous advantages mentioned, Tweddell et al. [25] and Ofstad & Brunner [37] argued TBL could be anxiety-provoking for faculty members and students unfamiliar with the process or uncomfortable with their active learner roles. In our study, this fear is identified in the qualitative analysis and confirmed in the quantitative analysis, with 55% of the students agreeing that they were anxious regarding the practice novelty and number of activities.

When focusing on the student's active role, 36% of the students said not having the teacher's content explanations caused anxiety. Despite that, during classes, students had the opportunity to clarify their doubts or discuss questions with the teachers or through burning questions, which 38% of them recognised as a good practice to reduce anxiety. These results follow those obtained by Punja et al. [51], who mentioned that teachers' roles as facilitators and experts are essential.

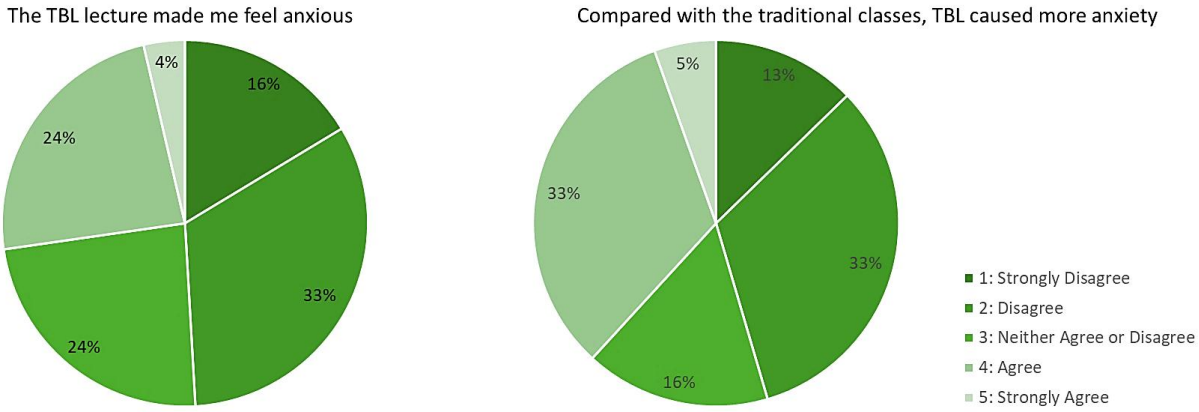

Figure 3. TBL Lecture and Traditional Lecture Anxiety

Considering the opinions about the relationship between TBL elements and anxiety, the pre-class preparation was not identified as anxiety-provoking (Figure 4). However, the number of materials to study was identified by 44% of the students as an anxiety promotor. They felt anxious seeing the number of pages to read or videos to watch and afraid of being unable to understand the content. As in previous studies, students agreed that their anxiety decreased as they became more aware of the content. On the other hand, having to prepare all the content alone and having no clear understanding of the contents were also the statements in which students mostly agreed about feeling anxiety [7, 37].

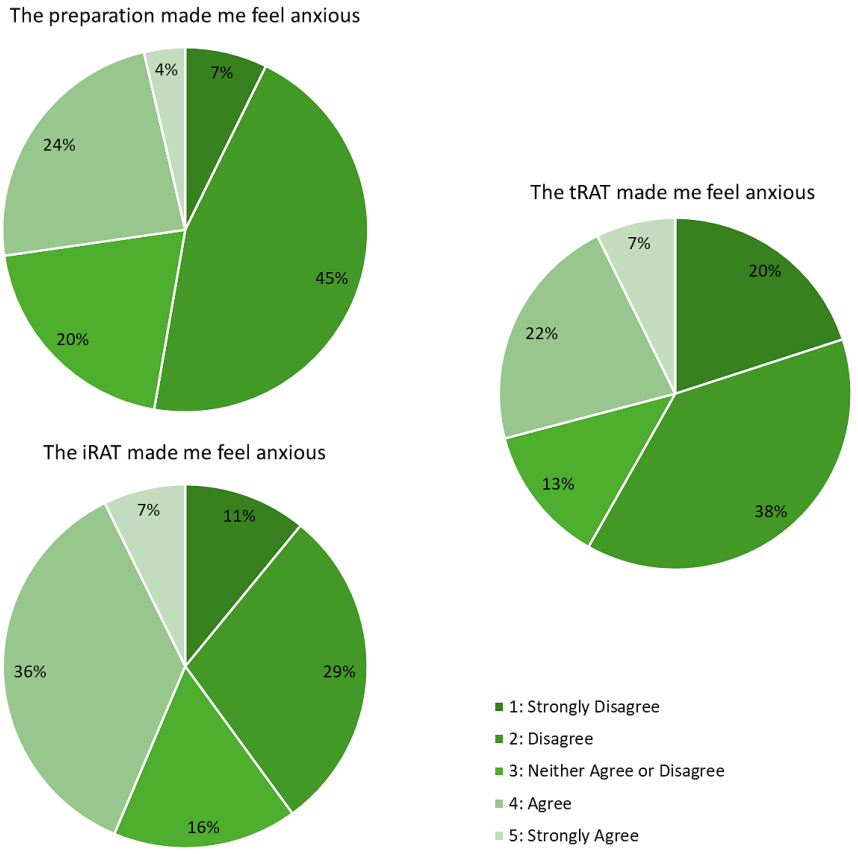

Figure 4. Preparation, iRAT and tRAT, and Anxiety

In the iRAT, 36% of the students agreed they had some associated anxiety (Figure 4). In the iRAT, we found the lowest grade averages, indicating that anxiety may interfere with the student's performance on individual tests and negatively affect their grades, as England et al. [12] pointed out. This anxiety was also associated when students gave incorrect answers (33% of students) or did not know the answer to a question (36% of students). As reported by Cooper et al. [7] and England et al. [12], one of the leading causes of anxiety in active learning practices is continuous assessment, with students worried about the impact on their final grades instead of being focused on learning the contents. Finally, during this phase, most students disagreed about feeling anxious due to the individual responsibility or the individual answer's visibility to others.

During the group tests, tRAT, students were generally not anxious (Figure 4). Chen et al. [38] and Cooper et al. [7] discovered that team anxiety was associated with students being uncomfortable when sharing their thoughts with other members or not reaching a consensus. In this study, the opposite is identified, with 42% of the students feeling less anxious as they had team support and the possibility to learn from others, as also mentioned by Cooper et al. [7]. These opinions are under the Rezaee et al. [23] conclusions that team discussion can reduce anxiety while increasing students' awareness. Additionally, Cooper et al. [7] also found that possible anxiety sources could be related to other students knowing their answers and making some judgments about a wrong answer; however, in this study, 42% of the students disagreed about feeling anxiety related to it, mentioning several times that it was a good thing for questions discussion. Still, in this phase, students did not consider the individual impact on the team's answers or vice versa as anxiety-provoking, contrary to what England et al. [12] exposed. In that study, it is also mentioned that students need to have high confidence in their group members to trust in graded assignments. However, that was not verified here, as they felt more secure and less anxious, knowing that the others were also aware of the content or when they did not know the correct answer to a question, and the teammates could help them [7, 22]. Despite that, when their team answered incorrectly several tRAT questions, anxiety was revealed.

Students also reported some anxiety regarding the last phases, application exercises (45%) and handouts (38%) (Figure 5), mainly due to the time available to solve them in the class, similar to what was found by Cooper et al. [7]. Around 49% also indicated that anxiety was associated with situations where they did not understand the application exercise as it could compromise the project performance and expose their knowledge weaknesses to the other members. Additionally, Cooper et al. [7] stated that anxiety could be associated with comparing students' knowledge; in this research, 29% agreed. The difficulty of handouts, solving exercises involving Python, and seeing the other team members solve the exercises faster did not impact anxiety significantly.

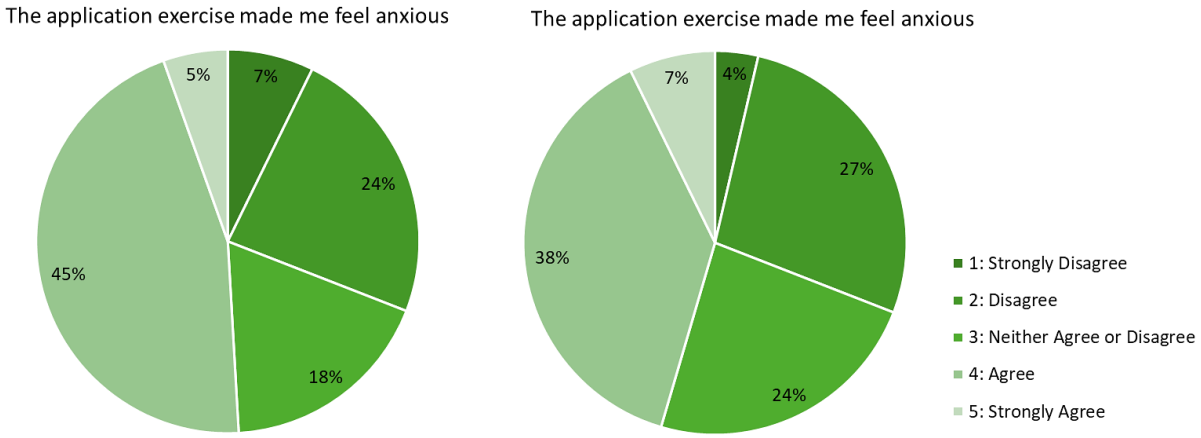

Figure 5. Application Exercise and Handout Anxiety

Finally, by crossmatching the different anxiety scores obtained with grades, it was verified that an association between anxiety and the student's grades was identified when observing the anxiety detected at the end of the semester. Barbosa-Camacho et al. [52] noted that anxiety could inspire students to put more effort into their studies, leading to better individual performances and suggesting a positive impact of anxiety. This research agrees with the cited results as we verified that students with higher anxiety scores, moderate or severe, obtained higher grades in TBL activities, non-TBL activities, and final exams. This facet confirms the positive impact of anxiety on their academic performance, which was a critical driver for them to be better prepared for the classes. Students obtained better grades in the TBL activities performed with a group, tRAT, and handouts than in individual activities. This outcome reinforces the findings of the qualitative and quantitative analysis that students feel less anxious when answering with a group and obtain better grades.

4-2- Future Adaptations to Reduce Team-Based Learning Anxiety

Considering all the critical points discussed, teachers may implement adaptations to decrease anxiety in some contexts. To manage the fear of the unknown at the beginning of the semester, we suggest implementing a tutorial class so that students can have contact with the new pedagogical approach before classes start. We also propose presenting a summary of the contents for the following class to decrease anxiety about not having teachers' explanations before the assessments.

To deal with the anxiety associated with not understanding class preparation content, we propose creating and promoting a forum where students can share their questions with colleagues and professors. The amount of content to study during that class preparation was also mentioned as a cause of anxiety. The teachers may reduce those or create more dynamic ways to provide them, such as gamification. In the individual assessment phase, students felt high anxiety levels mainly related to the grades associated with it, so teachers could remove the grade associated with it similarly to what was proposed by Deardorff et al. [36] with group application exercises or decrease the weight associated with it.

During the application exercise phase, the main anxiety issues were associated with the time available to execute them in the classes or not understanding them, so the teachers may increase the time associated with this activity and provide closer assistance.

This study had several limitations regarding the sample size, diversity, and subjectivity, affecting the power to detect differences in those variables. The sample was chosen for convenience, so it did not represent the whole institution population; hence, the applied quantitative approaches verified an anxiety increase that TBL may cause and other factors. This study tried to explore these factors by conducting individual interviews in which students could express their opinions. In future works, some of those caveats may be explored, and similar research that extends and exhaustively examines the relation between TBL and a traditional lecture-based class will be implemented by comparing both classes in the same anxiety context. The quantitative approaches should focus on comparing students' performance on a standardised outcome, controlling for prior academic performance between an active learning course and a traditional lecture course, and maintaining all other variables the same.

5- Conclusions

This study aimed to explore the TBL practice and its impact on students' AL throughout a semester. It provided feedback to the teachers to evaluate the student's overall performance and adapt some of the activities by conducting semi-structured interviews and exploratory and statistical analysis. We identified differences in the students' AL, comparing the semester's beginning and ending by applying a GAD-7 anxiety survey, with the highest levels of anxiety being achieved at the end of the semester.

EDA was implemented to get a better overview of the student's characteristics and opinions and cover the relationship between several variables. It allowed the discovery of various insights; for instance, students with moderate or severe anxiety obtained the highest grades in the TBL activities and final grades. This discovery validated what other authors have discussed: AL does not permanently harm students' academic performance. It could be a key driver for them to be better prepared for the classes and benefit their learning process.

The AL differences during the TBL activities were assessed to identify the ones that had the potential to increase or decrease those levels. Five elements harmed student's anxiety before the classes and during the pre-class preparation, namely the fear of the unknown like what was mentioned by other authors, the amount of content to study, not having the teacher explain the contents before the class, having to prepare them alone or do not understand some of them in the preparation. During the iRAT, students also felt some associated anxiety, especially when giving an incorrect answer or not understanding a question.

In the tRAT, similarly to the iRAT, anxiety was related to several incorrect answers. At the same time, the application exercise and handout were allied when students did not understand the contents, seeing the other team members solving the exercises faster and the amount of time they had to perform the activities. The latter, contrary to what has been exposed by different authors, had a negative influence on anxiety.

Some practices allowed the anxiety to decrease. Peer learning was one of those. While students were in groups, they were developing their communication capabilities and interactivity. That environment and the possibility of posing anonymous questions made them feel more comfortable when exposing their doubts and, consequently, less anxious. The teacher's explanations during classes, having low-weighted evaluations, tests performed with a team, and individual and team content awareness were also identified as instruments to reduce anxiety.

This study indicated not only that TBL can have a positive impact by reducing students' anxiety levels during group activities, being an excellent alternative to the traditional lecture-based classes, but also that it can improve the student's awareness of their learning process, teamwork, discussion, and individual learning capabilities and responsibilities also supporting the anxiety reduction for other evaluations. This practice may be adapted to rectify possible elements that negatively impact the anxiety context.

6- Declarations

6-1- Author Contributions

Conceptualization, A.M. and R.H.; methodology, A.M. and R.H.; software, A.M. ; validation, M.A. and R.H.; formal analysis, A.M., M.A., and R.H.; investigation, A.M.; resources, A.M. and R.H.; data curation, A.M. and R.H.; writing—original draft preparation, A.M.; writing—review and editing, A.M., M.A., and R.H.; visualization, A.M. and R.H.; supervision, M.A. and R.H.; project administration, R.H.; funding acquisition, R.H. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6-3- Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

6-4- Institutional Review Board Statement

The Research Ethics Committee from the institution approved this research (STAT2022-11-37997).

6-5- Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

6-6- Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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